

EUPHORBIA GENUS IN BOTANICAL GARDEN IASSY – FEATURES OF LIVING PLANT COLLECTION

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Abstract: The *Euphorbia* genus collection from the Botanical Garden of Iassy comprises 28 taxa, of which 18 are originated in the dry areas of South Africa. Most of the South-African species have conservative value, belonging to different zoological categories, at national or international level. The experience of cultivating items from the collection led to the establishment of characteristics concerning cultivation particularities, which are useful for horticultural purposes. The morphological studies of the plants cultivated in GBI greenhouses put together with information from specialty literature have permitted the development of an artificial key, useful in determining species from the collection.

Key words: *Euphorbia* genus, Botanical Garden Iassy, artificial taxonomic key

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Introduction

The *Euphorbia* genus is considered the second richest in the angiosperms group, the number of circumscribed species are appreciated at approximately 2000 (Berry et al. 2016) or even 2250 (Esser 2009). The genus has a cosmopolitan distribution (except Antarctica), the majority of the species occurs in tropical and subtropical Africa and America. The habitats occupied by species are very diverse, from forest steppe to arid areas; biological forms are very diverse as well, from herbaceous annual plants to trees with impressive dimensions. Characteristic for this polyphyletic genus is the inflorescence structure, named cyathium; likewise spurges are recognized for their irritant latex (Carter & Leach 2001).

The genus' name seems to have come from the name Euphorbus (Euphorbos) of the Greek physician of Juba (Iuba) II, king of Mauritania (a Berber kingdom that was part of present-day western Algeria and northern Morocco) from first century AD (Smith 1849).

The succulent species from the genus are difficult to herborize and to study from herbaria (Carter 1987b), so living collections (*ex situ*) are very useful for taxonomical studies. Most of the historical herbaria with *Euphorbia* species that originated from arid areas of Africa and Madagascar are situated in European botanical gardens (Jstor 2013). Likewise, the first descriptions of species from African flora were made by representatives cultivated in European gardens (mostly at Kew) (Brown et al. 1925).

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From the point of view of ecological education which is specific to botanical gardens, the spurges have a special importance. The succulent species of the genus are useful to illustrate the phenomenon of convergence: in the arid areas of Africa, spurges occupy ecological niches corresponding with the cactuses in American deserts (Felger & Henrickson 1997). Otherwise, the confusions between succulent spurges and cactuses are very frequent, especially among amateur horticulturists who are passionate about succulent plants. The *Euphorbia* genus has the advantage of having representatives in spontaneous European flora (including Romania) (Ciocârlan 2000); so it is easy to access the virtual image of a non-succulent species (e.g. *E. amygdaloides*, *E. cyparissias* - alior, laptele cucului) to understand the variety of morphological forms of the genus and the amplitude of modifications due to adaptation to extreme environmental conditions.

Material and methods

The material is represented by a collection of the *Euphorbia* genus of Botanical Garden Iassy - GBI (Ifrim 2016, Lazăr 1982, Rugină et al. 1995). This collection comprises more than 100 items which arise from 28 taxa, one of them having horticultural provenance (*E. tithymaloides* 'Variegatus' syn. *Pedilanthus tithymaloides* 'Variegatus'). *E. myrsinites* are cultivated outdoors, in climatic condition of Iassy, while other taxa are cultivated in protected conditions, in the greenhouses. Most *Euphorbia* representatives have been obtained by international exchange of botanical material among botanical gardens (Index Seminum 1975-2017) and was cultivated and maintained with the initial name (the correct identification was impossible for a very long time because due to a lack of specialty literature).

The redetermination of taxa on the base of specialty literature (Berry et al. 2016, Carter 1987a, Court 2000, Carter & Leach 2001, Carter 2002, Schmidt et al. 2002, Steinmann 2003, Loffler & Loffler 2005) led to the following modifications: the species received and cultivated as *Euphorbia caput-medusae*, *Homalocladium platycladum* and *Monadenium erubescens* were redetermined as *E. flanaganii*, *E. cotinifolia*, and *E. guentheri* respectively.

Also the items cultivated as varieties from *Synadenium grantii* were redetermined and two taxa were identified: *E. bicompecta* var. *rubra* (*S. compactum* var. *rubrum*) and *E. umbellata* (*S. grantii*). The confusions concerning *S. grantii* were frequent especially in the horticultural domain and this aspect was clarified by Susan Carter (1987a), a specialist of the genus.

Results and discussion

The *Euphorbia* genus collection from GBI is restricted (28 taxa), but valuable by their taxonomical, phytogeographical, morphological and horticultural diversity.

From a taxonomical standpoint, it is difficult to establish the infrageneric classification of the studied species, because with time there was a diversity of taxonomic treatment in the genus, many subgenera, sections, subsections, series and subseries having been proposed (Carter 1994). One of the more recent classifications conducted following the analyses of molecular data split the genus in four well-defined

clades treated as subgenera; these are variably represented in our collection (Table 1). The majority of the taxa (18) originated from the African continent, five of them from Central and South America, two from Canary Island, and two taxa come from the Mediterranean region, tropical Asiatic areas respectively (Berry et al. 2016, Brown et al. 1925).

Many taxa have conservative (zoological) value, at a regional (SANBI 2012) or international level (IUCN 2018). Among the factors which threaten the local populations are the destruction of habitats, the invasion of adventive species and the over collection in ornamental or medicinal purpose.

The commerce with plants from the *Euphorbia* genus collected from nature or obtained by cultivation is internationally regulated by CITES. These regulations affect many of the species from our collection. *Euphorbia obesa* is the most popular among succulent euphorbias and it is one of the first native South African species to be noted as threatened by extinction; already as early as 1915 it was considered an endangered species (SANBI 2012).

From table 1 it is obvious that most species belong to LC categories, which demonstrates the need for local population studies.

Table 1 Taxonomical, biogeographical and zoological aspects of species from GBI collection

No.	Sub-genus	Species	Distribution	IUCN	CITES	Red List RSA
1.	Athymalus	<i>E. bubalina</i> Boiss.	E Cape (RSA)		Appx. II	
2.		<i>E. flanagani</i> N. E. Br.	E Cape (RSA)		Appx. II	V
3.		<i>E. ferox</i> Marloth	E, W Cape (RSA)			LC
4.		<i>E. globosa</i> (Haw.) Sims	E Cape (RSA)		Appx. II	E
5.		<i>E. obesa</i> Hook. f.	E Cape (RSA)		Appx. II	E
6.	Ch.	<i>E. cotinifolia</i> L.	S and centr. Am.			
7.		<i>E. pulcherima</i> Willd. ex Klotzsch	S Mexico, Guatemala			
8.	Esul ^a	<i>E. aphylla</i> Brouss. ex Willd.	Ile. Canare		Appx. II	
9.		<i>E. myrsinites</i> L.	NE Medit. Reg.			
10.		<i>E. bicompecta</i> Bruyns var. <i>rubra</i> (S. Carter) Bruyns	Kenya			
11.	Euphorbia	<i>E. caerulescens</i> Haw.	E, V reg. Cap (RSA)		Appx. II	LC
12.		<i>E. canariensis</i> L.	Canary Islands	LC 2017	Appx. II	
13.		<i>E. grandicornis</i> Goebel ex N.E. Br.	SE Africa		Appx. II	LC
14.		<i>E. grandidens</i> Haw.	S Africa			LC
15.		<i>E. guentheri</i> (Pax) Bruyns	Kenya			LC

16.	<i>E. ingens</i> E. Mey ex Boiss.	RSA, Angola, Swaziland				LC
17.	<i>E. lactea</i> Haw.	Tropical Asia				
18.	<i>E. leuconeura</i> Boiss.	Madagascar	Vu 2004			
19.	<i>E. millii</i> Des Moul.	Madagascar	DD 2004	Appx. II		
20.	<i>E. pteroneura</i> A. Berger	S Mexico, Guatemala		Appx. II		
21.	<i>E. ramipressa</i> Croizat	Madagascar				
22.	<i>E. stenoclada</i> Baill.	Madagascar, Mozambic	LC 2004	Appx. II		
23.	<i>E. tirucalli</i> L.	SE Africa	LC 2017	Appx. II		LC
24.	<i>E. tithymaloides</i> L.	Tropical and subtropical America				
25.	<i>E. tithymaloides</i> L. subsp. <i>smalli</i> (Millsp.) V. W. Steinm.	Cuba				
26.	<i>E. trigona</i> Mill.	Central Africa		Appx. II		
27.	<i>E. umbellata</i> (Pax) Bruyns	Tropical Africa		Appx. II		

Appx. – Appendix (CITES), Am. – America, Ch – *Chamaesyce* (subgen), Medit. Reg. – Mediterranean Region, RSA – Republic of South Africa

In conditions of a protected plant culture that are provided in the greenhouses of the GBI bloom almost half of the cultivated species: *Euphorbia bicompecta* var. *rubra*, *E. caeruleascens*, *E. cotinifolia*, *E. flanaganii*, *E. guentheri*, *E. leuconeura*, *E. millii*, *E. myrsinites*, *E. obesa*, *E. pteroneura*, *E. pulcherima*, *E. tithymaloides*, *E. tithymaloides* 'Variegatum', *E. umbellata*. Of those, only two form fruit as well: *E. cotinifolia* and *E. leuconeura*. The latter is the only one that adapted very well to the greenhouse conditions and auto-propagated, sometimes behaving as a greenhouse weed.

The representatives of the *Euphorbia* genus are generally less exigent toward environmental conditions. This fact alongside this sometimes bizarre aspect (at succulents and/or spiny plants) constitutes one of the reasons for their frequent cultivation by horticulture enthusiasts. In the almost 50 years of experience in cultivation in protected condition in GBI greenhouses, particularities in the behavior of different taxa could be observed. Thus the succulent spiny species (e.g. *Euphorbia grandicornis*) are sensitive to water excess, the varieties of *E. tithymaloides* are susceptible to fungal attack (powdery mildew), and *E. leuconeura* can be a host for insect pests *Eriosoma lanigerum* (wooly aphid).

The items that exist in the collection have been morphologically analysed, with observations focused on the characteristics of the vegetative organs. The morphological characteristics were selected based on the importance they presented in making the difference between taxa and have been codified for easier use (Table 2). Thus were established 12 binary characters (Mapaya 2003) for which presence or absence is mentioned.

Table 2 Morphological characters of vegetative organs from *Euphorbia* plants collection

No.	Species	1	2	3	4	5	6	7	8	9	10	11	12
1.	<i>E. aphylla</i>	+	+	-	-	-	-	-	-	-	-	-	-
2.	<i>E. bicompecta</i> var. <i>rubra</i>	+	+	-	-	-	-	+	+	-	-	-	+
3.	<i>E. bubalina</i>	-	+	-	+	-	-	+	+	-	-	-	+
4.	<i>E. canariensis</i>	+	+	+	-	-	-	-	+	+	+	+	+
5.	<i>E. caerulescens</i>	+	+	+	-	-	+	-	+	+	+	-	+
6.	<i>E. cotinifolia</i>	+	-	-	-	-	-	+	+	-	-	-	+
7.	<i>E. ferox</i>	-	+	+	-	-	-	-	-	+	-	-	+
8.	<i>E. flanagani</i>	-	+	-	+	+	-	+	-	-	-	-	-
9.	<i>E. globosa</i>	-	+	-	+	+	+	+	-	-	-	-	+
10.	<i>E. grandicornis</i>	+	+	+	-	-	+	-	-	+	+	+	+
11..	<i>E. grandidens</i>	+	+	+	-	-	-	-	-	+	+	-	+
12.	<i>E. guentheri</i>	-	+	-	+	-	-	+	+	-	+	+	+
13.	<i>E. ingens</i>	+	+	+	-	-	+	-	-	+	+	-	+
14.	<i>E. lactea</i>	+	+	+	-	-	+	-	-	+	+	-	+
15.	<i>E. leuconeura</i>	-	+	-	-	-	-	+	+	-	-	-	+
16.	<i>E. millii</i>	+	+	-	-	-	-	+	+	-	-	-	+
17.	<i>E. myrsinites</i>	-	+	-	+	-	-	+	-	-	-	-	+
18.	<i>E. obesa</i>	-	+	-	-	-	-	-	-	-	-	-	+
19.	<i>E. pteroneura</i>	-	+	-	-	-	-	+	+	-	-	-	+
20.	<i>E. pulcherima</i>	+	-	-	-	-	-	+	+	-	-	-	+
21.	<i>E. ramipressa</i>	+	+	+	-	-	-	-	-	+	+	-	-
22.	<i>E. stenoclada</i>	+	+	-	-	-	-	+	-	+	+	-	-
23.	<i>E. tirucalli.</i>	+	+	-	-	-	-	-	-	-	-	-	-
24.	<i>E. tithymaloides</i>	+	+	-	-	-	-	+	+	-	-	-	+
25.	<i>E. tithymaloides</i> subsp. <i>smalli</i>	+	+	-	-	-	-	+	-	-	-	-	+
26.	<i>E. tithymaloides</i> Variegata	+	+	-	-	-	-	+	+	-	-	-	+
27.	<i>E. trigona</i>	+	+	+	-	-	+	+	-	+	+	-	+
28.	<i>E. umbellata</i>	+	+	-	-	-	-	+	+	-	-	-	+

Plant characters: 1. Growth habit: (-) herbs; (+) shrub / tree; 2. Stems: (-) non-succulent; (+) succulent; 3. Stems shape: (-) cylindrical; (+) with angles; 4. Stems surface: (-) without tubercles; (+) with tubercles; 5. Central stem different from side branches: (-) absent; (+) present; 6. Stem constriction: (-) absent; (+) present; 7. Leaves: (-) conspicuous; (+) reduced and/or scale-like; 8. Petiole: (-) absent; (+) present; 9. Stipules or inflorescence modified as spines: (-) absent; (+) present; 10. Spines: (-) without spine shield; (+) with spine shield; 11. Prickles: (-) absent; (+) present; 12. Foliar scars: (-) conspicuous; (+) inconspicuous.

Some stem characters are specific to the *Euphorbia* genus (e.g. spine shields or floral peduncles modified as spines) or rarely encountered (e.g. tubercles present especially in succulent spurges, ± prominent or foliar scars, with the typical aspect).

In different publications (with popularization or scientific purposes) the appearance of some succulents (including those part of the *Euphorbia* genus) is considered bizarre. To accurately describe this appearance, terms as suggestive as possible are used, such as: cactiform, pencil-stemmed. A controversial term is

“medusoid” (Swanepoel 2012), which has no morphological signification, but the species with such a shape were under the subject. *Medusea* (Haw.) Pax & K. Hoffm at some point. The “medusoid” term defined the group of species characterized by “a thick, wedge-shaped, flattopped, coarsely tuberculate stem from which a mass of snakelike, more finely tuberculate branches spread out, each of which arises in the axil of a tubercle on the stem” (Peirson et al. 2013).

In the GBI collection there can be identified most of these morphological types, some of them only specific to the *Euphorbia* genus: cactiform (*E. canariensis*), candelabriform (*E. ingens*), coralliform (*E. stenoclada*), globose (*E. obesa*), medusoid (*E. flanaganii*) and pencil-like/pencil-stemmed (*E. aphylla*) (Rauh 1992).

The last term can be found in the specialty publications, having a generic character, while the term coralliform is preferred by the French authors (Cremers, 1978, Leandri 1952) specialized in the *Euphorbia* genus study.

The relevant characters of the vegetative organs can be diagnostic characters, which can be useful in the case that many *Euphorbia* species do not bloom, especially in conditions of protected culture. The combination of all obtained data with information from specialty literature permitted the making of an artificial identification key for the species of the collection, key that can be useful to specialists (in the botanical or horticultural domain) or to amateur horticulturists.

1a.	Plants arbustive or arborescent, with conspicuous main stem	2
1b.	Plants with other characters	12
2a.	Plants spiny	3
2b.	Plants not spiny	20
3a.	Plants with persistent leaves	4
3b.	Plants without leaves (leaves soon caducous or present only in juvenile stages)	5
4a.	Plants with green stems (photosynthetic), angular, with spines in pairs arranged along the edges	<i>E. trigona</i>
4b.	Plants with cylindrical stems (non angular), with spines uniformly arranged, without forming apparent lines	<i>E. millii</i>
5a.	Spines singular, represented by the apical tips of terminal ramification	<i>E. stenoclada</i>
5b.	Spines stipular, in pairs	6
6a.	The spine shields form a continuous edge	7
6b.	The spine shields distinct, don't form a continuous edge	8
7a.	Stems 3 (rarely 4) - angular, spines with different dimensions, the biggest more than 5 cm long	<i>E. grandicornis</i>
7b.	Stems 4 (rarely 5) - angular, spines with different dimensions, the biggest more than 1.5 cm long	<i>E. caerulea</i>
8a.	Stems green, with conspicuous whitish spots in the central area, arranged in a scalariform way	<i>E. lactea</i>
8b.	Stems green, only sometimes with inconspicuous whitish spots	9
9a.	Plants with branches with the same thickness as the main stem	10
9b.	Plants with terminal branches thinner (3-4 times) than the main	11

stem	
10a. Branches with straight edges, stems slightly spiraled	E. canariensis
10b. Branches with wavy edges, width conspicuous constriction along the stem	E. ingens
11a. The second and third order branches cylindrical near base, approximately 0.8 cm diameter, then biangular	E. grandidens
11b. The second and third order branches cylindrical near base, approximately 1.2 cm diameter, then tri- or quadrangular	E. ramipressa
12a. Terminal branches pencil-like	13
12b. Terminal branches with other features	15
13a. Stems and their branches are segmented by constrictions situated close to the foliar scar; foliar scar conspicuous	E. pteroneura
13b. Stem and branches not segmented; foliar scar inconspicuous ...	14
14a. Branches green with fine longitudinal white striations; leaves present only on new growth and ephemeral	E. tirucallii
14b. Branches green without longitudinal white striations; leaves never visible	E. aphylla
15a. Leaves with very long petiole, whorled; plants may reach 4-5 m in height	E. cotinifolia
15b. Leaves alternately arranged or opposite, never whorled	16
16a. Leaves petiolate	E. pulcherima
16b. Leaves sessile or slightly petiolate	17
17a. Stems mostly 4-angled, edges with numerous cartilaginous stipules	E. leuconeura
17b. Stems with other features	18
18a. Leaves ovate to lanceolate, foliar scars approximately triangular	19
18b. Leaves obovate or oblanceolate, foliar scars ovate, conspicuous	20
19a. Leaves with margin ± obvious dentate, with leaves entirely or maculate reddish	E. bicompecta var. rubra
19b. Leaves with whole edges, ciliate	E. umbellata
20a. Leaves green, midvein with a thick keeled beneath	21
20b. Leaves variegated with white and pink	E. tithymaloides Variegatus
21a. Leaves ovate or lanceolate, 1-16 cm long, internodes often 4-5 cm	E. t. subsp. tithymaloides
21b. Leaves elliptic, 2-7 cm long, internodes often 1-5 mm	E. t. subsp. smallii
22a. Stems spiny	23
22b. Stems not spiny	24
23a. Plants with spines represented by undeveloped peduncles	E. ferox
23b. Plants with stipular spines	E. guentheri
24a. Plants with solitary stem, globose, apparently without leaves, leaves only apical, caducous	E. obesa

24b.	Plants with many foliate stems, leaves persistent	25
25a.	Plants with stems erect, leaves more than 4 cm long, in upper third of the stem	E. bubalina
25b.	Plants with pendent or prostrate stems, leaves smaller than 4 cm long, disposed along the entire length of the stem or branches ...	26
26a.	Stems with tubercles	27
26b.	Stems without tubercles	E. myrsinites
27a.	Plants with cylindrical branches, leaves persistent along the entire length	E. flanaganii
27b.	Plants with branches from globose segments, leaves persistent on the terminal segments or in the apical area of the other	E. globosa

Conclusions

The *Euphorbia* genus collection of the GBI provides an important study material and the observation results can contribute to the deeper knowledge of this polyphyletic genus. The morphological observations on items from *Euphorbia* collections permitted the making of an artificial identification key, useful for permanent monitoring of private (plant enthusiast) or specialized collection (botanical gardens, horticultural institutions).

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